

Missouri Passenger Rail Corridor Study:

Southwest Chief/BNSF Marceline Subdivision

Public Highway-Rail Grade Crossing Safety & Consolidation Study

M.P. 252.38 – M.P. 442.53



Executive Summary

Railroads in Missouri serve as a vital catalyst in sustaining and growing Missouri's economy: both for the movement of freight and people. Missouri has three (3) passenger rail routes, operated by Amtrak: The Southwest Chief, Texas Eagle, and Missouri River Runner. This study focuses on the Southwest Chief passenger rail route that utilizes BNSF's Marceline subdivision and is identified as an Amtrak national priority route. As the demand for rail services increases daily, a focus on maintaining a safer corridor is imperative.

On the backbone of improving safety, the 102nd Missouri General Assembly was requested by the Missouri Highway and Transportation Commission to leverage a historic level of state funding towards achieving this priority for the Fiscal Year 2024 budget. As a result, the Missouri Department of Transportation (MoDOT) identified the need to perform an independent safety study on each of these corridors, with the primary objective of increasing public safety by identifying improvement opportunities for public passive crossings of passenger rail corridors.

This section of the BNSF's Marceline Subdivision and Amtrak's Southwest Chief Route is critically important for the movement of freight and people. The Southwest Chief is a high national priority route for Amtrak, connecting over 2,200 miles between Los Angeles and Chicago. In addition to passenger rail, the Marceline Subdivision is a significant segment of BNSF's system, part of the Southern Transcon connecting southern California with Chicago, and serves as BNSF's primary intermodal route in the US.

Currently, this corridor services over 60 daily trains, including 58+ freight and two (2) passenger trains. Freight trains operate up to 70 MPH and passenger trains operate up to 90 MPH. The resulting heavy rail traffic impacts local communities daily, with a total of 195 crossings within the study limits, including 137 at-grade crossings - 95 of which function as public, 40 private, and 2 public pathway. The corridor has 78% of existing crossings with active warning devices (Flashing Lights & Gates) and 22% with passive-only warning devices, including 72 active and 21 passive-only crossings. **Since 2000, there have been 27 incident occurrences at grade crossings, of which three (3) resulted in fatalities and five (5) resulted in injuries - an average of 1.23 annual incidents .**

In an effort to maintain and improve a safer rail corridor and highway-rail grade crossings, the study recommends various improvements to enhance safety, reduce exposure, and eliminate grade crossing conflict points. Recommendations vary in complexity and cost, ranging from advanced warning enhancements, crossing realignment, approach grade improvements, flashing lights & gates upgrades, closures, new roadway connections, ADA sidewalk enhancements, and grade separations.

CORRIDOR AT A GLANCE



60 trains daily
(58+ freight & 2 passenger)

70MPH max speed freight
90MPH max speed passenger



137 at-grade crossings

95 public
40 private
2 pathway



27 incidents (since 2000)

3 incidents resulting in fatalities

5 incidents resulting in injuries

Implementation of the plan is anticipated to occur over many years and require significant financial resources, with an initial focus on upgrading, closing, or enhancing the existing 21 passive-only crossings. Many improvements will require additional feasibility & environmental studies in addition to significant stakeholder and public engagement. **Recommended corridor improvements are anticipated to cost approximately \$63.3M, and result in a 90% reduction in grade crossing exposure risk and 23% in annual incident occurrences.**

TIER 1 PUBLIC AT-GRADE IMPROVEMENTS

\$7.6 M



7 Upgrades
(Lights & Gates)



3 Passive Enhancements



11 Closures

CORRIDOR RECOMMENDATIONS

\$63.3 M



Inclusive of Tier 1 Improvements



7 Upgrades
(Lights & Gates)



25 Closures



3 Passive Enhancements



4 Grade Separation



7 Approach Grade Improvements

90%

Reduction in Exposure Index Rating



23%

Est. Annual Crash Reduction by 0.81

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INTRODUCTION & BACKGROUND



Introduction & Background

Purpose & Need

Railroads in Missouri serve as a vital catalyst in sustaining and growing Missouri's economy: both for the movement of freight and people. With an increased emphasis and a national focus on bolstering intercity passenger rail, it is vital to provide a safer and more efficient transportation network exists to not only keep the regional and national economies moving but to save lives. In alignment with the Missouri Department of Transportation's (MoDOT) mission of providing a safe, innovative, and reliable transportation system, improving safety along passenger rail corridors is of critical importance.

Missouri has three (3) passenger rail routes, operated by Amtrak: the Southwest Chief, Texas Eagle, and Missouri River Runner. The Southwest Chief route utilizes BNSF's Marceline Subdivision, while the Texas Eagle utilizes the Union Pacific's (UP) DeSoto Subdivision, and the Missouri River Runner utilizes UP's Jefferson City and Sedalia Subdivisions. The Southwest Chief and Texas Eagle routes are identified by Amtrak as national priority routes.

As the demand for rail services increases daily, MoDOT identified the need to perform an independent safety study on each of these corridors and develop a comprehensive master plan for corridor-wide safety improvements. To accelerate the implementation of safety improvements at highway-rail grade crossings, Missouri Highway Transportation Commission (MHTC) requested \$50 Million in state funding through the 102nd Missouri General Assembly for the Fiscal Year 2024 budget (FY24). The final FY24 budget allocated the requested \$50 Million in state funding for Missouri rail corridor safety improvements.

As a result, in March 2023, the MoDOT Multi-Modal Rail Division commissioned Crawford, Murphy & Tilly, Inc. (CMT) to perform a grade crossing safety study of Amtrak's Southwest Chief Corridor operated on BNSF's Marceline Subdivision from M.P. 258.47 – M.P. 442.53. The study spans 10 counties and over 20 local roadway authority jurisdictions. The scope of this study examined the public at-grade crossings within the study limits with a primary objective of increasing public safety by identifying improvement opportunities for public passive crossings along this passenger rail corridor. MoDOT's goal for this study was an independent, objective evaluation devoid of influence by MoDOT, railroads, or municipalities.

This section of the BNSF's Marceline Subdivision and Amtrak's Southwest Chief Route is critically important for the movement of freight and people. The Southwest Chief is a high national priority route for Amtrak, connecting over 2,200 miles between Los Angeles and Chicago. In Missouri, Amtrak has 2 stations along the Southwest Chief: Kansas City (Union Station) and La Plata. In addition to passenger rail, the Marceline Subdivision is a significant segment of BNSF's system, part of the Southern Transcon, that connects southern California with Chicago and serves as BNSF's primary intermodal route in the US.



Background

The section of the Southwest Chief (BNSF Marceline Subdivision) under review is located in northern Missouri, with the project limits spanning from approximately Independence, MO at the west and to the Des Moines River at the east. The corridor spans 190+ miles across 10 counties including Clark, Scotland, Knox, Adair, Macon, Linn, Chariton, Carroll, Ray, and Jackson County.

This corridor is currently double-tracked with various sidings, resulting in up to 3 tracks at various grade crossings. **Currently, the corridor averages over 60 daily trains, including 58+ freight and two (2) passenger trains. Freight trains operate up to 70 MPH and passenger trains operate up to 90 MPH.** The resulting heavy rail traffic impacts local communities daily, with 137 public at-grade crossings within the study limits, 95 of which function as public - 40 private, and two (2) public pathway. The corridor has 78% (74 total) of existing crossings with active Flashing Lights & Gates (FLG) warning devices and 22% (21 total) passive-only crossings. With a primary focus on safety, reducing incident occurrences and severity is of utmost importance. Since 2000, this corridor has experienced 27¹ total incidents, including 3 fatalities and 5 injuries.

Coinciding Safety Studies

MoDOT, BNSF Railway, and other Local Public Agencies (LPA) have completed or are in the process of completing grade crossing safety studies along specific sections of the Southwest Chief/BNSF Marceline Corridor and are not a part of this study. Recommendations presented within these studies listed below are referenced within this corridor-wide improvement plan. The respective study report should be referenced for all details, costs, safety analysis, and recommendations that occur within these limits.

- BNSF Jackson County Study² – This study was completed by Olsson in August 2022 between Mileposts (M.P.) 433.83 and M.P. 442.53 that are also included within the limits of this study.
- Chariton County Study³ – This study was completed by Howe Company, LLC in April 2023 between M.P. 259.79 and M.P. 368.20 and are also included within the limits of this study.

These areas were independently studied and reviewed under this corridor-wide study and sought to identify opportunities for enhancements and safety applications that would result in consistent treatments at public grade crossings across the Southwest Chief/BNSF Marceline corridor.

¹ Incidents Reported by FRA as of 12/31/2022

² See BNSF Jackson County Study, August 2022

³ See Chariton County Study, April 2023

EXISTING CONDITIONS



Existing Conditions

This section of the Southwest Chief/BNSF Marceline corridor under review is an east-west corridor that spans approximately 190 miles through mostly-rural northern Missouri. As part of BNSF's southern Transcon, the corridor services a high volume of train traffic of over 60 trains daily, including 58+ freight trains and two (2) passenger trains. Rail speed varies with maximum timetable speeds of 70 MPH for freight and 90 MPH for passenger.

Amtrak provides service of one (1) daily train in each direction on this route. Pre-pandemic ridership averaged nearly 92,000 riders annually but fell to an average of nearly 36,000 in 2020 and 2021. Post-pandemic trends reflect a return towards pre-pandemic ridership with over 60,000 riders in 2022 and early 2023 trending with an even greater increase in riders.

Existing Crossing Summary

Currently, there are a total of 195 crossings within the study limits, including 137 at-grade crossings comprised of 95 public, two (2) public pathway, and 40 private, as summarized below. The corridor has 78% (74 total) active public grade crossings and 22% (21 total) passive-only crossings.

Field Visits were conducted on each of the public grade crossings within the study limits by CMT, MoDOT, and BNSF. Data and observations were collected to inform the project team of current conditions, identify safety hazards, and exposure reduction opportunities. In various cases, factors were modified from compiled data to match field conditions present (ie. feasible speed, and sight distance).

CROSSING SUMMARY	
CROSSING TYPE	# CROSSINGS
Public At-Grade	95
Private At-Grade	40
Public Pathway At-Grade	2
Public Grade-Separated	56
Private Grade-Separated	2
TOTAL	195

SW CHIEF PASSENGER RAIL STUDY - BNSF MARCELINE SUBDIVISION										
	CLARK	SCOTLAND	KNOX	ADAIR	MACON	LINN	CHARITON	CARROLL	RAY	JACKSON
CROSSING POSITION	3 Passive 6 Active	2 Passive 4 Active	5 Active	3 Passive 2 Active	1 Passive 9 Active	1 Passive 9 Active	4 Passive 10 Active	2 Passive 13 Active	4 Passive 11 Active	1 Passive 5 Active
	8 Public Grade-Sep. 6 Private At-Grade	3 Public Grade-Sep. 2 Private At-Grade 1 Private-Grade Sep.	6 Public Grade-Sep. 3 Private At-Grade	7 Public Grade-Sep. 1 Private At-Grade	8 Public Grade-Sep. 8 Private At-Grade 1 Public At-Grade Pathway	5 Public Grade-Sep. 2 Private At-Grade	3 Public Grade-Sep. 2 Private At-Grade 1 Private Grade-Sep.	9 Public Grade-Sep. 3 Private At-Grade 1 Public At-Grade Pathway	5 Public Grade-Sep. 9 Private At-Grade	2 Public Grade-Sep. 4 Private At-Grade 1 Private Grade Sep.
TOTAL	23	12	14	13	27	17	20	28	29	12
195										

Grade Crossing Summary

Incident history data was compiled from BNSF and the Federal Rail Administration (FRA) Database for grade crossings within the study. While incident history is typically analyzed on a 5-year basis, incident data was compiled since Year 2000 for this study, providing a more holistic view of incident frequency and a deeper understanding of driving behaviors occurring near grade crossings.

Of the 95 public grade crossings, there has been a total of 27 incident occurrences from 1/1/2000 – 12/31/2022¹, of which three (3) resulted in fatalities and five (5) resulted in injuries - a historical average of 1.23 annual incidents.

Notably, this incident frequency is lower than anticipated, when compared with other corridors with a similar number of grade crossings. While subjective, and not confirmed, the project team speculates this may be attributed to the high volume of rail traffic and train speeds along this corridor resulting in an increased local awareness of grade crossings along this rural corridor. Additionally, many crossings are located in rural areas and often provide access for a few residences and/or farms – potentially resulting in fewer unfamiliar drivers in the area.

The incident history, indicates specific crossings, date(s), and injury type(s) that have been documented. According to incident reports, **41% of incidents occurred as a result of drivers stopping on crossing, 22% of stalled vehicles, 19% driver did not yield to train, and 11% driver drove around or thru the gate.**

SW CHIEF PASSENGER RAIL STUDY - BNSF MARCELINE SUBDIVISION TOTAL INCIDENTS (2000-2022)	
Type	# Incidents
FATAL	3
INJURY	5
PDO	19
TOTAL # INCIDENTS	27
*Incidents reported by FRA as of 12/31/2022	

SW CHIEF PASSENGER RAIL STUDY - BNSF MARCELINE SUBDIVISION AT-GRADE RAILROAD INCIDENT SUMMARY						
COUNTY	STREET	US DOT #	RR M.P.	INCIDENTS	INJURY STATUS	DATE
CLARK	CO RD 164	005011E	258.470	1	Uninjured	11/26/2002
	CO RD 113	005022S	268.248	1	Uninjured	4/1/2014
SCOTLAND	COLT LANE	005038N	275.363	2	Uninjured	4/4/2000
	ROUTE U	005040P	277.831	1	Injured	2/17/2015
MACON	MO SH 156	005091A	313.955	1	Uninjured	7/1/2001
	PRIVATE CROSSING	005110C	327.445	1	Uninjured	8/24/2015
CHARITON	FELT ST	005278V	360.560	1	Injured	9/26/2020
	CO RD 113	005284Y	363.876	1	NA	1/4/2004
CARROLL	CO RD 223	005290C	371.839	1	Killed	6/27/2022
	CO RD 617	005318R	393.730	1	NA	2/5/2003
RAY	CO RD 326	005300F	382.173	1	Uninjured	10/1/2001
	PRIVATE CROSSING	005336N	407.020	1	Injured	11/20/2000
RAY	PIGG LANE	005357G	421.530	2	Injured	8/2/2004
	CAMDEN RD	005352X	416.798	1	Uninjured	4/19/2007
JACKSON	LONG LAKE RD	005339J	408.749	1	Uninjured	7/12/2002
	PRIVATE CROSSING	005362D	426.220	1	Injured, Killed	4/19/2020
JACKSON	ATHERTON RD	005368U	431.941	2	Uninjured	2/21/2009
	MABEL ST	005372J	43.826	3	Uninjured	10/30/2013
JACKSON	COURTNEY RD	005373R	43.586	5	Injured	5/8/2021
	VERMONT ST	005383W	442.527	1	Uninjured	5/12/2011
*Incidents reported by FRA as of 12/31/2022						

¹ Incidents Reported by FRA as of 12/31/2022

Safety Analysis

An existing conditions safety analysis was performed on the corridor to provide an understanding of existing hazard locations and set a baseline for recommended improvement comparison and safety prioritization. The safety analysis approach is developed based on multiple state and federally-recognized evaluation methods at grade crossings to quantitatively analyze safety benchmarks. Coupled with qualitative safety information gathered from MoDOT, BNSF, stakeholders, and incident reports, a comprehensive safety evaluation was performed.

Exposure Index Ratings

The Exposure Index Rating provides a numerical value of safety at each public grade crossing. The State of Missouri has developed its own rating formula that considers ADT, speed, geometry, lighting, and many other factors that contribute to the safety of a crossing². An adjusted exposure index rating (AEI) was applied to the analysis to account for the warning devices' safety factor³. A higher exposure index rating represents a higher safety risk, while a lower exposure index rating reflects a lower safety risk for at-grade crossings.

Existing conditions recorded from FRA inventories and field-collected data were utilized in developing exposure index ratings. **The existing corridor has an Adjusted Exposure Index Rating (AEI) of 160,661 with an average AEI of 1,728 per crossing.** See *Recommended Corridor Improvements* for the proposed AEI.

Crash Prediction Models

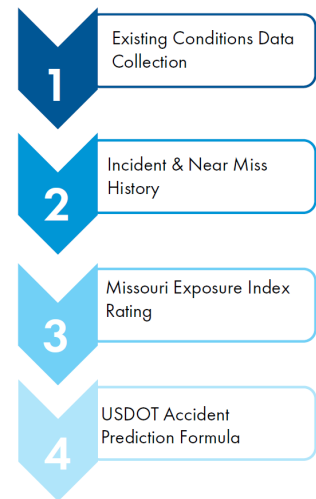
Crash Prediction models were generated for each of the public grade crossings within the corridor study limits. Crash prediction was derived from the USDOT Railroad-Highway Grade Crossing Handbook⁴ as utilized on the FRA's Web Accident Prediction System (WBAPS). The formulas consider various factors such as ADT, speed, lighting, warning devices, and historical crash data. Four (4) separate formulas are utilized in the development of the Crash Prediction Model utilized on this corridor:

- USDOT General Basic Accident Prediction (Existing Conditions)
- Final Accident Prediction (General Formula + Crash Data)
- Fatal Accident Probability
- Injury Accident Probability

Through a combination of the above formulas, existing crash rates were derived for the 95 public grade crossings. Twenty-five (25) year models were generated for the existing/no-build conditions that developed total annual crash prediction (crashes per year), in addition to fatal, injury, and Property Damage Only (PDO) crash probabilities. **The existing corridor has an existing annual crash prediction of 3.48, including a 0.51 fatal and 1.02 injury.** See *Recommended Corridor Improvements* for the proposed Crash Prediction.

Near Misses

Another safety evaluation tool utilizes near-miss reports, as collected by train operations. These are self-reported by the railroad in which a train engineer thought a crash with a vehicle almost occurred. While not actual crashes, these cause alarm for safety as they had the potential to result in a fatal or serious injury crash between a train & highway vehicle. **According to BNSF data, no near-miss reports have been documented on this corridor in the last five (5) years⁵.** It should be noted that while no reports have been recorded, this does not mean near-misses have not occurred.



² Missouri Exposure Index Formula (<https://spexternal.modot.mo.gov/sites/cm/CORDT/RDT03017.pdf>)

³ CMT Multiplier (adopted from Connecticut Exposure Index)

⁴ USDOT Railroad-Highway Grade Crossing Handbook, 3rd Edition (July 2019)

⁵ Near-Miss Data as of 4/30/2023

RECOMMENDED CORRIDOR IMPROVEMENTS



Recommended Corridor Improvements

Introduction

During this study, improvements were developed based on the priority of enhancing safety along Amtrak's Southwest Chief/BNSF's Marceline Subdivision. Collaboration throughout the study with MoDOT and BNSF helped identify key safety concerns, LPA & public coordination history, and regional connectivity and access needs. While the primary goal of this study is to identify improvements for public passive crossings, the study sought to develop a long-term safety and consolidation master plan for the Southwest Chief/BNSF Marceline Corridor.

All improvements recommended under this study are the result of an independent review of crossing safety and the development of a corridor-wide master plan to deploy a consistent approach. The basis of recommended improvements includes data collection and collaboration with MoDOT and BNSF Railway, safety analysis, field visits, and field diagnostics.

Environmental Considerations

This study focused on the high-level conceptualization of improvements, and no environmental investigations or reports have been completed. Various recommended improvements are anticipated to require right-of-way acquisition and environmental clearances, which will require socioeconomic, farmland, threatened & endangered species, wetlands, cultural resources, and other environmental investigations as part of the preliminary engineering phase.

Public Involvement

MoDOT's goal for this study was an independent, objective evaluation devoid of influence by MoDOT, railroads, or municipalities. No stakeholder or public involvement has occurred to date, so as to not interfere with the independent study results. Necessary stakeholder and public engagement is anticipated and recommended to follow this study.

Adjacent Railroad Improvements

In Carroll and Ray Counties, the Norfolk Southern parallels the BNSF Railway for approximately 30 miles, at varying proximity. Various proposed improvements at BNSF grade crossings may necessitate improvements at Norfolk Southern crossings as well, including upgrades to Flashing Lights & Gates (FLG), roadway profile adjustments, and closures.

Corridor Recommendation Summary

Recommended improvements have been developed at public highway-rail grade crossings along the Southwest Chief/BNSF Marceline Subdivision to increase the safety of highway road users, train operators and crew, and Amtrak passengers. In addition to the primary study objective of improving public passive grade crossing safety by reducing exposure incident occurrences, overall efficiency and reliability of the passenger and freight rail transportation system is anticipated to increase as a direct result of safety improvements and an anticipated reduction in incidents.

Recommended improvements have been organized in a tiered implementation approach to better define prioritization, funding mechanisms, and schedule feasibility, as described below. See *Implementation Strategies* for additional details on the tiered implementation approach. All grade-separated and private grade crossings will be maintained, except when the implementation of new roadways may eliminate the need for crossing access.

- **Tier I** - Recommended as the top priority for the corridor to significantly improve safety at public passive crossings, with a target implementation of 1 year.
- **Tier II** - Recommended as those that require coordination, design engineering, or crossings where existing active warning devices are present. Target implementation of approximately 18 months.
- **Tier III** - Improvements that require additional coordination, design engineering, environmental clearances, and/or cost-share improvements.
- **Tier IV** - Improvements that require significant coordination, feasibility studies, design engineering, environmental clearances, and significant funding resources likely achieved through leveraging federal grant funding programs.

Tier I Improvements

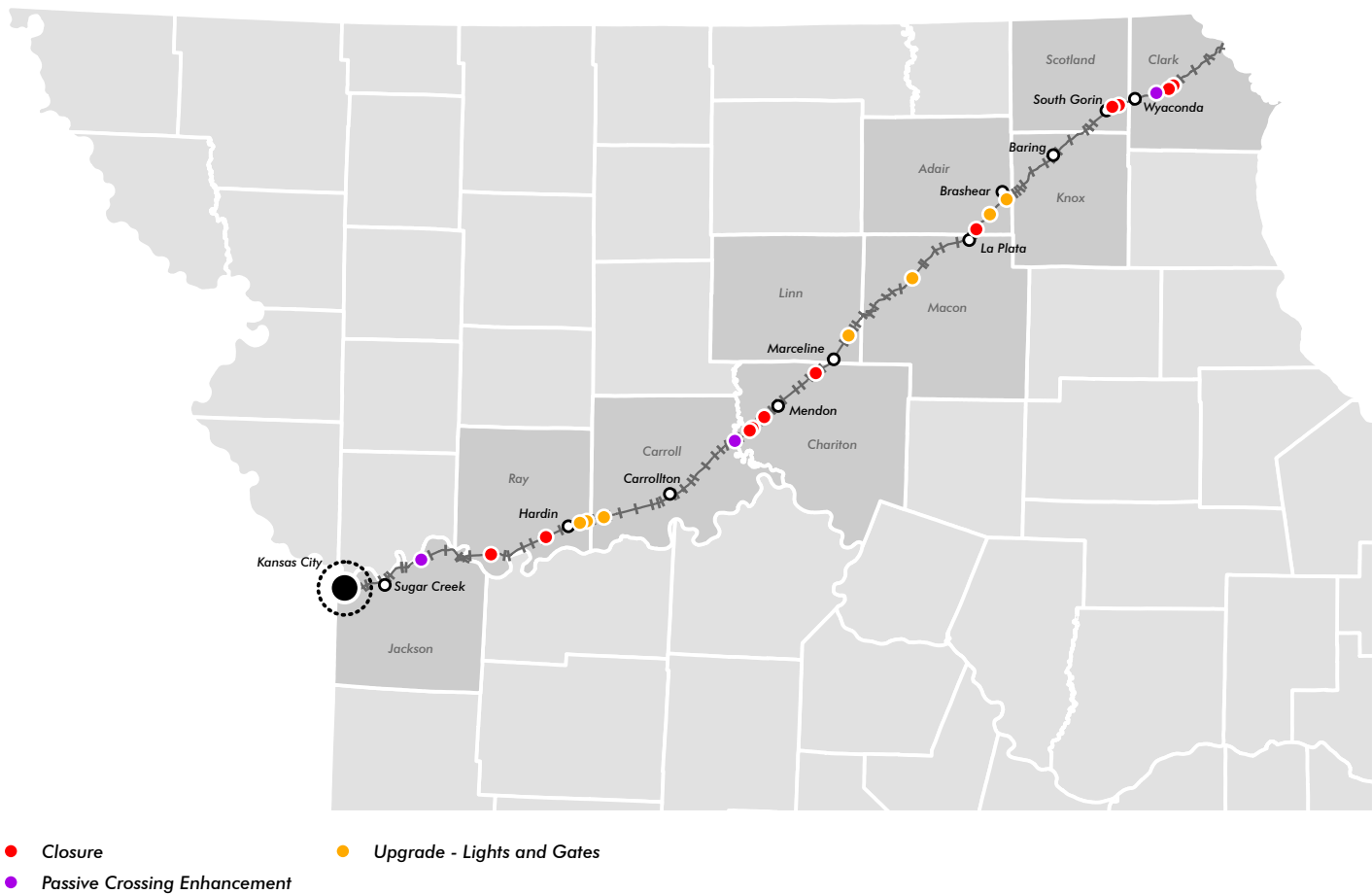
Upon implementation of the corridor improvements, only 1.4% of passive public grade crossings (3 total) will remain, a 20% reduction from current conditions under the initial Tier I Improvements. Tier I represents the immediate needs along the corridor to reduce the grade crossing exposure: the 21 passive public grade crossings. Additionally, these improvements represent cost-effective solutions that can more reasonably occur within an approximately 1-year period. As a result, the following improvements are proposed for the 21 passive public crossings: seven (7) FLG upgrades, 11 closures, and three (3) passive crossing enhancements.

PASSIVE TIER 1 SUMMARY	
Upgrade	7
Closure	11
Remain Passive	3

As a result of field diagnostics with MoDOT, BNSF, CMT, and the respective LPA performed in May 2023, three (3) passive public grade crossings are proposed to remain in place due to significantly low traffic volumes and limited need/frequency for access across the railroad. These locations are recommended for improved signing (advanced warning), and/or enhanced security gates, as summarized below.

SOUTHWEST CHIEF PASSIVE TIER I RECOMMENDATIONS				
US DOT #	ROAD	CITY	COUNTY	TIER I PASSIVE CROSSING RECOMMENDATIONS
005017V	Co Rd 136	Near Kahoka	Clark	Closure w/ Connection to CR152
005020D	Co Rd 159	Near Kahoka	Clark	Closure w/ CR113/Sycamore Ln Grade-Sep
005022S	Co Rd 113	Near Wyaconda	Clark	Remain Passive. Install Signing Improvements
005038N	Colt Ln	Near Gorin	Scotland	Closure w/ CR113/Sycamore Ln Grade-Sep
005039V	Hicks Rd	Near Gorin	Scotland	Closure w/ CR113/Sycamore Ln Grade-Sep
005073C	Clemson Ln	Near Hurdland	Adair	Upgrade - Lights & Gates
005079T	Century Ln	Near Brashear	Adair	Upgrade - Lights & Gates
005084P	Archer Ln	Near Gibbs	Adair	Closure
005106M	Estate Pl	Near Elmer	Macon	Upgrade - Lights & Gates
005133J	Meadow Rd	Near Bucklin	Linn	Upgrade - Lights & Gates
005267H	Bristol Ave	Near Marceline	Chariton	Closure
005284Y	CR 113 / Porche Prairie Ave	Near Mendon	Chariton	Closure w/ Connection to Santa Fe
005286M	CR 107 / Atchison Ave	Near Triplett	Chariton	Closure w/ Wabash Road Connection
005287U	CR 132 / Snyder Rd	Near Triplett	Chariton	Closure
005289H	Co Rd 361	Near Bosworth	Carroll	Remain Passive. Install Signing Improvements
005324U	Co Rd 505	Near Norborne	Carroll	Upgrade - Lights & Gates
005326H	Hisinger Lake Rd	Near Hardin	Ray	Upgrade - Lights & Gates
005327P	Little Brick Rd	Near Hardin	Ray	Upgrade - Lights & Gates
005341K	Gill Rd	Near Henrietta	Ray	Closure w/ Connection to 84th St.
005355T	CR 353/ Sand Pit Rd	Near Fleming	Ray	Closure
005374X	Eaton Rd	Sibley	Jackson	Remain Passive. Install Security Gates & Signing Improvements

TIER 1 RECOMMENDED IMPROVEMENTS



Tier II-IV Improvements

Improvements that cannot be reasonably implemented within a 1-year period or those that require significant financial investment are included within Tier II-IV. Recommended improvements are anticipated to significantly improve safety, through various methods: increasing driver awareness & visibility, improving connectivity & redundant routes, reducing crossing exposure, and eliminating conflict points through crossing closure/elimination.

- Signing Enhancements - During field visits along the corridor, the project team frequently observed the lack of or ineffective advanced warning signs at grade crossings along the corridor. In many cases, signs were either not present, stolen, damaged, or had ineffective reflectivity. **Implementation of W10-1 and W10-3 Advanced Warning Signage is recommended as a cost-effective countermeasure to increase driver awareness, especially in rural areas along this corridor.**

After further review, MoDOT has indicated an interest in publishing a Grade-Crossing Advanced Warning Signage Program for road authorities in the State of Missouri to reimburse the cost of installing and/or replacing missing or ineffective advanced warning signs at public grade crossings.

- Pavement Markings - While many road approaches along this corridor are non-paved, various paved crossings could benefit from the installation or replacement of pavement markings. This countermeasure is a proven tool recommended by FHWA to increase driver awareness, especially in nighttime and inclement weather conditions. As a cost-effective tool, it is recommended that all paved roadway approaches have pavement markings installed (lane lines, RR symbols, and stop bars).

Additionally, at locations with high traffic volumes where roadway curvature at the crossing is present, deploying a high-reflectivity pavement marking is recommended. It is recommended that pavement markings extend through the crossing where complex crossing geometries exist.

- Roadway Profile & Approach Improvements - A frequent cause of stalled vehicle-train incidents at grade crossings is a result of roadway profile conditions that cause a low-profile vehicle to become stuck on the tracks. Various locations were noted in the field that could benefit from such improvements to reduce the frequency of stalled vehicles and create a more favorable crossing condition. Approach improvements are strongly recommended at crossings that service a high volume of farm-vehicle traffic.
- Off-System Improvements - In certain cases, implementing improvements along other parts of the local transportation network may improve connectivity and access, resulting in crossing closures becoming feasible. During field visits, the project team noted a few instances where this could occur, including improving a roadway profile to reduce flooding, replacing a deficient river bridge to restore connectivity, and improving unused public roads to restore traffic.
- ADA & Pedestrian Improvements - In many instances, insufficient ADA crossings were observed in place at crossings where sidewalk was present at or near grade crossings. It is recommended that ADA improvements be made to provide compliant sidewalk width, slopes, drop-offs, and settling. In some cases, where adjacent crossings are proposed to be closed, implementing ADA improvements at those that remain open is recommended to maintain safer pedestrian access, specifically in population centers.



- Crossing Realignment & Expansion - In locations where crossing skews reduce sight distance or crossing widths do not accommodate farm vehicles, it is recommended to realign the crossing for improved geometrics, including a more perpendicular crossing for improved sight distance, installing additional crossing surface panels, and other geometric improvements for added safety.
- Crossing Consolidation & Closure - Closure of at-grade crossings aligns with the study objective of increasing passenger rail corridor safety by eliminating all exposure and risk for a vehicle-train incident. Where access and local connectivity can be maintained through the existing road network or new roadway improvements, crossing closure is recommended to significantly improve safety.

This corridor features a significant number of rural, low-volume crossings. While many are necessary to remain for access, there is an opportunity to significantly improve safety and reduce exposure through a crossing consolidation plan.

- Grade Separations - Where a crossing closure is not feasible due to traffic volumes and/or access concerns, grade-separations are recommended to eliminate the at-grade crossing and any highway-rail exposure. While these improvements maintain access and eliminate incident risk, the capital cost to implement such improvements requires significant financial resources and thus have been programmed in Tiers III & IV.

It is recommended that grade-separations be prioritized by traffic volumes to achieve the greatest safety benefit, starting with all Missouri state-maintained numbered routes.



Tier I-IV Corridor Recommendations

Corridor Recommendations*



25
Closures



7
Upgrades
(lights & gates)



3
Passive Enhancements



3
Crossing
Realignments



34
Advanced
Warning
Enhancements



2
Added
Side
Flashers



4
ADA Path
Improvements



7+
Miles Connector
Roads



4
Grade
Separations



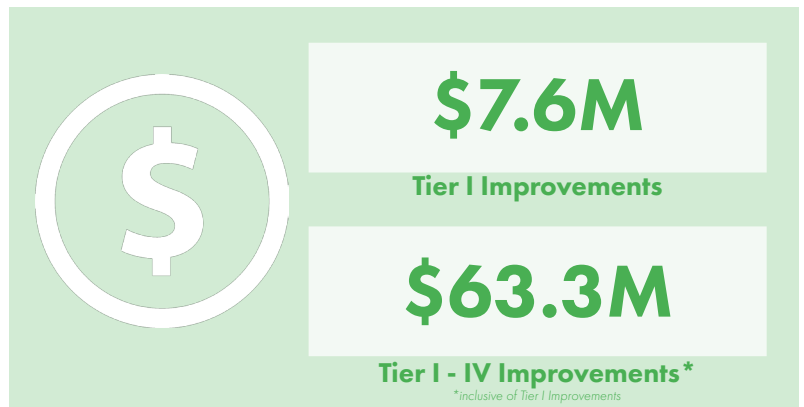
7
Approach
Grade
Improvements

*inclusive of Tier I Improvements

Improvement Cost Summary

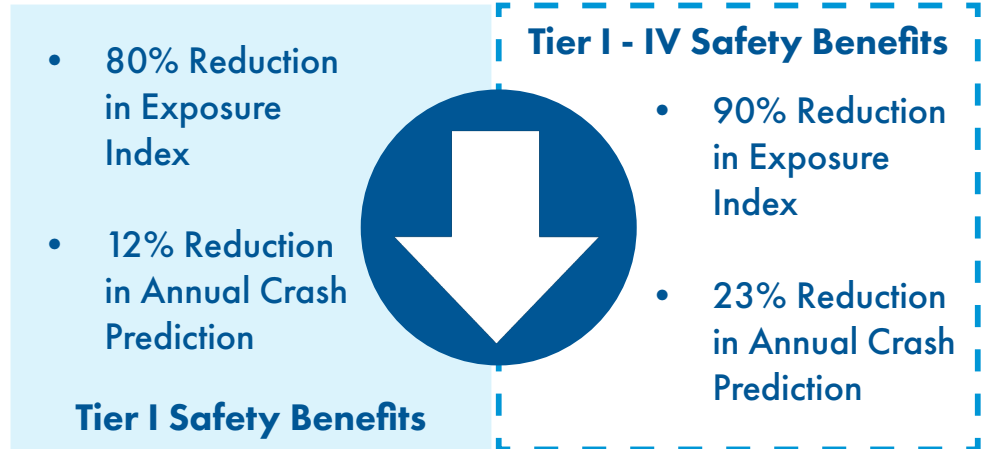
A high-level engineering opinion of probable cost was developed for each of the proposed improvements. Costs were developed from high-level conceptual layout based on GIS, Aerial, available LiDAR data, and Spring 2023 BidTabs. These costs are provided for programming purposes, are subject to change and should not be considered actual construction costs. Additional improvements or scope of work may be deemed necessary upon further evaluation, public and stakeholder involvement, or additional factors unknown at the time of this study that may impact final costs.

Tier I Costs, which consist mainly of FLG upgrades and closures, are anticipated to cost approximately **\$7.6 Million**. The full corridor plan (Tier I-IV) is anticipated to cost approximately **\$63.3 Million**.



Proposed Corridor Safety Analysis

As detailed in *Existing Conditions*, a similar safety analysis approach was applied to the proposed improvements to quantify the safety improvement. The proposed Exposure Index Rating and Crash Prediction models were generated based on improvements directly related to the crossing position, status, and warning device for the long-term corridor plan. Interim improvements are not quantified in these safety models, and the final long-term recommendation was used at these respective locations.



While additional improvements such as pavement marking, lighting, signing, approach grade, and other improvements are anticipated to improve overall safety at highway/rail grade crossings, these countermeasures are not accounted for within these safety models, **resulting in significant additional safety benefits.**

The elimination of 18 passive-only crossings, either through FLG upgrade or closure, results in a significant safety benefit. **Tier I Improvements are anticipated to reduce the exposure rating by 80% (-128,672) and annual crash prediction by 12% (-0.43).**

Upon full implementation of corridor-wide improvements, the corridor will result in the FLG upgrade of seven (7) crossings, 25 crossing closures, and four (4) grade-separations. The result in corridor-wide changes to crossing warning devices, position, or status are anticipated to **reduce the exposure rating by 90% (-143,950) and annual crash prediction by 23% (-0.81).**

IMPLEMENTATION STRATEGIES

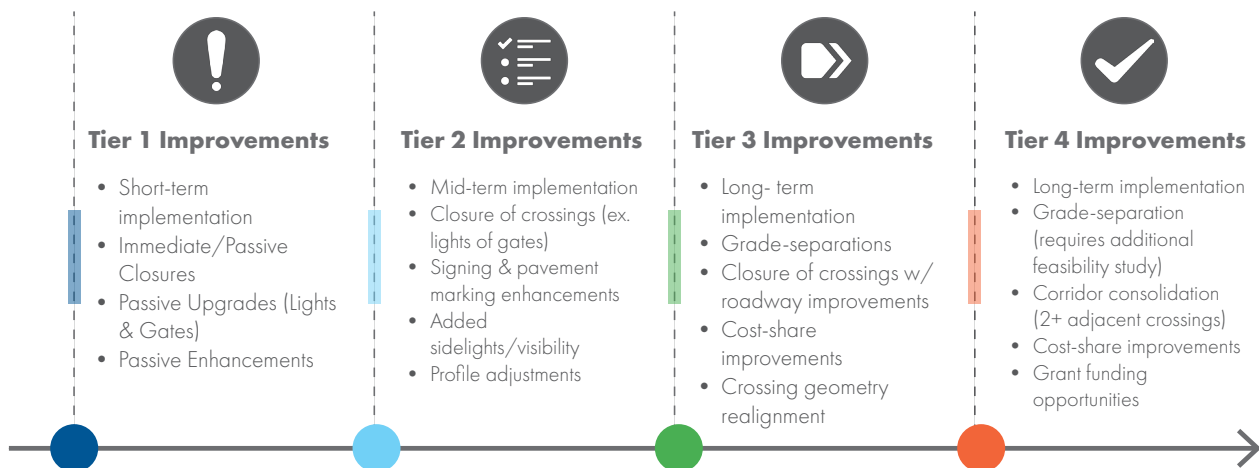


Implementation Strategies

The Southwest Chief/BNSF Marceline Corridor Study represents an independent review of grade crossing safety, with recommendations based on safety analysis, field visits, and conceptual-level design layout. Recommended Improvements are a result of the independent engineering review by CMT, without influence by MoDOT, the railroads, or local stakeholders. Improvement prioritization is presented based on improvement type, timeline, and funding and may be re-prioritized due to funding and other factors not analyzed by this study.

Improvement Prioritization

A generalized prioritization and improvement recommendation is defined below based on a tiered timeline approach. Improvements are first prioritized by safety and exposure index ratings, warning devices, and regional resiliency/local access. In many instances, new roadway improvements will be necessary to effectively facilitate the implementation of crossing closures and/or grade-separations. As such, Tier II-IV project programming should be considered on a holistic corridor-segment approach as funding mechanisms are identified and stakeholder involvement occurs.



Tier I Improvements are recommended as the top priority for the corridor to significantly improve safety and can be implemented rather efficiently with minimal stakeholder/public involvement, design engineering, and cost that can be implemented on a short term basis (approximately 1 year).

Tier II Improvements are recommended as those that require additional stakeholder/public involvement or design engineering. Additionally, Tier II also represents closures at crossings with existing active warning devices and roadway approach enhancements that can be implemented within several years.

Tier III Improvements include those that require additional stakeholder/public involvement, design engineering, environmental clearances, and/or cost-share improvements. These improvements are less straightforward and are determined as feasible improvements that can be implemented over the course of several years and funding cycles.

Tier IV Improvements include those that require significant stakeholder/public involvement, design engineering, environmental clearances, cost-share agreements, and additional feasibility or planning studies. Tier IV Improvements require significant funding to achieve and may be strategic projects to leverage federal funding programs.

Funding Mechanisms

While the improvements recommended within this study are designed to achieve safety, it is not fiscally practical to implement all improvements simultaneously. This study was commenced on the heels of historic state funding to prioritize highway/rail grade crossing safety. In May 2023, the 102nd Missouri General Assembly passed the 2024 Fiscal Year Budget, allocating \$50 million towards addressing grade crossing safety improvements throughout the state. **This funding will leverage the top priorities of this study: reducing exposure at passive crossings along passenger rail corridors.**

Additional funding programs and opportunities for partnership exist, and should be pursued as improvements are programmed for implementation, including:

- FHWA Section 130 Program
- FRA Consolidated Rail Infrastructure and Safety Improvements (CRISI) Discretionary Program
- FRA Railroad Crossing Elimination (RCE) Discretionary Program
- FHWA Promoting Resilient Operations for Transformative, Efficient, and Cost-Saving Transportation (PROTECT) Discretionary Program

Future partnerships with Local Public Agencies (LPA), BNSF Railway, Amtrak, and other key agencies should be sought to leverage state funding and accelerate implementation of the proposed improvements.

Strategic Implementation

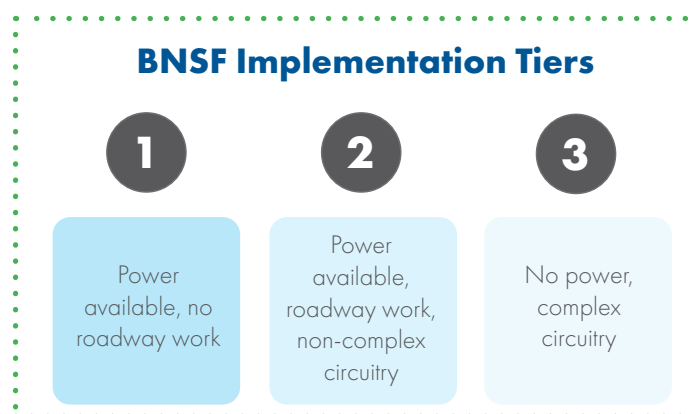
While unrealistic to fund a single-phase project approach, phased delivery of strategic and targeted project implementation sections will result in significant schedule and financial savings. Developing and implementing a Local Stakeholder Involvement Plan will be key for streamlining project success to enhance safety while maintaining vital local connectivity and achieving success in the eyes of the public.

As such, the following strategies are recommended:

1. Minimal Access Disruption
 - a. Active Warning Device Upgrade, Signing, Pavement Marking, Added Sidelights
2. Minor Access Disruption
 - a. Roadway Profile/Approach Improvements, Crossing Surface Improvements Only (No Signals), Closures tied to additional improvements (ie. River Bridges or Grade-Separated Crossings), Crossing Realignment, Temporary Road Closures/Detours
3. Significant Access Disruption & Permanent Traffic Diversions
 - a. Closures w/ Road Connections, Grade Separations, Long-term Road Closures/Detours, Permanent Road Closures

BNSF FLG Implementation

Additionally, BNSF has noted that they have a strategic tiered implementation plan for Flashing Lights & Gates (FLG) upgrades to streamline implementation. See *Risks & Challenges* section for additional information.



In Progress Safety Improvement Projects

MoDOT Multimodal and BNSF currently have partnered with LPAs at various locations along the corridor to address safety concerns at key crossing locations.

The following projects/crossings are currently programmed for improvements in the near future:

SOUTHWEST CHIEF PASSIVE TIER I IMPROVEMENTS			
COUNTY	US DOT #	ROAD NAME	PROGRAMMED/PLANNED IMPROVEMENT
Clark	005019J	CR 134	Profile Adjustment (S. Side)
	005020D	CR 159	Closure w/ CR 110 Grade-Sep. Project
	005027B	CR 404	Closure w/ CR 110 Grade-Sep. Project
Scotland	005035T	CR 111 /John Rd	Profile Adjustment (S. Side)
	005038N	Colt Ln	Closure w/ CR 110 Grade-Sep. Project
	005039V	CR 115/ Hicks Rd	Closure w/ CR 113/Sycamore Ln Grade-Sep. Project
Chariton	005267H	Bristol Ave	Closure
Ray	005326H	Hisinger Lake Rd	Upgrade to Flashing Lights & Gates (FLG)

Interim Projects for Immediate Safety Enhancements

In some instances, there may be a need for immediate safety improvements where long-term recommendations within Tiers III & IV will take time to develop agreements, require considerable funding resources, or require further feasibility analysis and engineering. At these locations, various enhancements are recommended that require significantly fewer funding resources, while providing considerable safety improvements, including but not limited to advanced warning signage, pavement marking, or security fencing. The interim improvements are recommended under Tiers I or II, where additional long-term improvements are being recommended. These projects are subject to change due to funding availability or agency prioritization. In certain cases, additional engineering studies are recommended to determine specific implementation methods to achieve the most valuable safety benefit.

Risks and Challenges

Implementing safety enhancements along the Southwest Chief/BNSF Marceline corridor is a priority for many agencies, including MoDOT, BNSF & Amtrak. MoDOT's goal of delivering on Tier I improvements within 1 Year is ambitious, but a notable and necessary priority that aligns with the allocated funding timeline.

As such, a high-level risk assessment was performed and the following risks and challenges were identified:

LPA Involvement

- Timeline for LPA/Road Authority Coordination & Agreements
- Public & LPA opposition to closures
- Closures tied to adjacent Grade-Separation Projects (ie. timeline for closure)

BNSF Railway

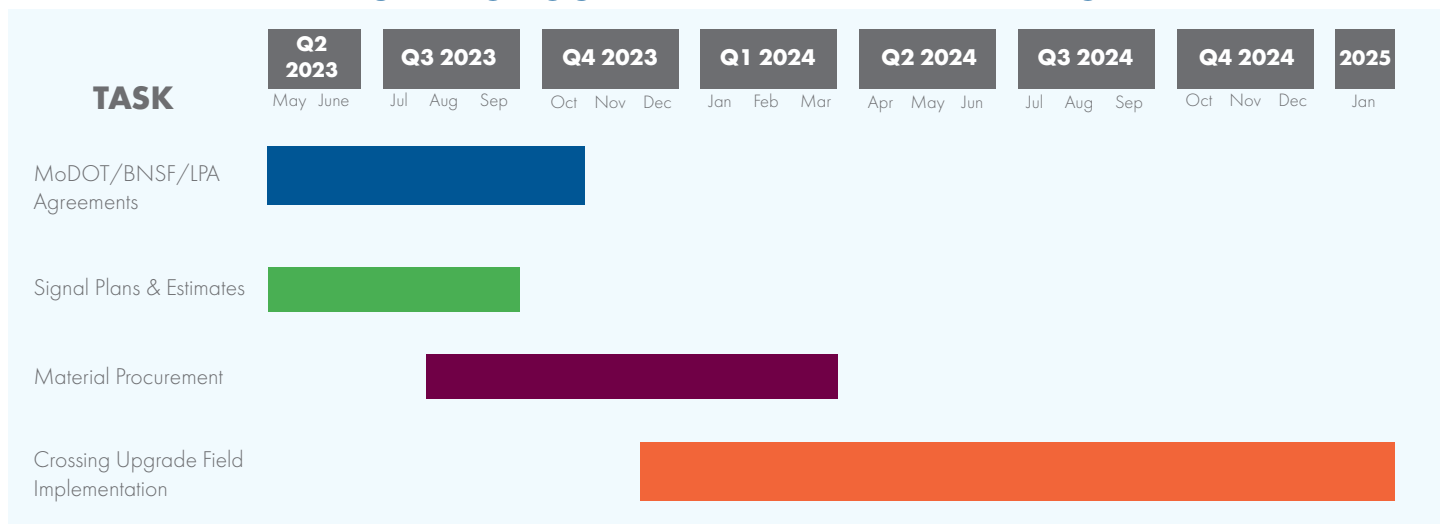
- Railroad Coordination & Review/FLG Design Timeline
 - Note: Standard BNSF/MoDOT Contract Agreement is anticipated to streamline this process
- Material Procurement - Est. 6-8month lead-time
- Workforce Availability
 - BNSF noted that Tier I Upgrades are double the annual FLG projects for a 5-state area (AR, IA, KS, MO, NE) that all utilize the same workforce. Other states still have projects planned for FY24 as well
 - Current MO Corridor Projects (Cherokee & Marceline Subdivisions) that require BNSF work in FY24
 - BNSF has indicated they will utilize signal & division gangs from across the system to boost workforce availability

External Factors

- Inflation & Budgetary Strain
- Significant Weather Delays

BNSF has indicated support for the project in pooling personnel and resources to expedite the Tier I Passive-upgrade implementation, including utilizing signal & division gangs, as available. Even with such resources, FLG implementation is anticipated to take up to 18 months for up to 10 FLG upgrades, as indicated by the timeline below provided by BNSF:

BNSF PROPOSED TIER 1 IMPLEMENTATION



1. Assumes up to 10 crossing upgrades
2. Assumes road approach work is completed in advance of signals
3. Does not account for significant weather delays